Design, Testing, and Modeling of the Direct Reactor Auxiliary Cooling System for AHTRs

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ABSTRACT

The advanced high-temperature reactor (AHTR) combines the coated-particle fuel and graphite moderator of the very high-temperature reactor with a liquid fluoride salt (LiF-BeF2, or FLiBe) as the coolant. One of the key design features of this reactor is the use of a direct reactor auxiliary cooling system (DRACS), which is proposed as part of the ultimate heat sink during transients for decay heat removal. The DRACS design has two sets of heat exchangers. The first one is submerged in the primary FLiBe coolant and is called the DRACS heat exchanger (DHX), and the second heat exchanger is above the DHX in the atmosphere and is named the natural draft heat exchanger (NDHX). Energy carried by the primary salt is transferred to the secondary salt in the DHX and then is dissipated to the surrounding air through natural convection in the NDHX.

The principal objective of this research is to test and model the heat transfer performance and reliability of the DRACS. In addition, component testing of fluidic diodes will be performed to examine the performance and viability of several existing fluidic diode designs. An extensive database related to the thermal performance of the heat exchangers will also be obtained, which will be used to benchmark a computer code for the DRACS design and to evaluate and perhaps improve existing heat transfer models. The database will also be valuable for evaluating the viability of the DRACS concept and benchmarking any related computer codes in the future. The experience of having a liquid fluoride salt test facility available, with its associated lessons learned, will greatly benefit the development of the fluoride salt-cooled high-temperature reactor (FHR) and eventually the AHTR programs.